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ZOOLOGY.

Plathelminthes.—Dr. Braun in Bronn's "Klassen und Ordnungen des Thier-Reichs," Bd. IV., catalogues the known species of ectoparasitic Trematodes. The following species are enumerated from North America: These are *Tristomum maculatum* from Diodon sp.; ? *Plectanocotyle elliptica* from *Labrax mucronatus; Polystomum coronatum* from *Cistudo carolina; Pol. oblongum* from *Dromochelys odoratus;* and *Sphyranura osleri* from *Necturus lateralis.* As soon as our species are systematically studied this list will be greatly increased.

Hermaphroditism in the Crustacea.—Dr. Ishikawa[1] describes the hermaphrodite glands in *Gebia major.* The anterior part of the reproductive organ is male, and the vasa deferentia are much as usual in Decapods. The posterior half of the organ is female, and is much larger than the rest. In sections the germinal band in the testicular portion is seen giving rise to spermatozoa, while in the ovarian part the same band forms eggs. At the point of junction eggs and spermatozoa are commingled. Grobben thinks that these eggs cannot escape through the narrow generative opening, and hence must atrophy at certain seasons of the year. This hermaphroditism was found to occur in all of twenty males examined.

Observations on a Remarkable Development in the Mudfish.—An interesting example of abnormal development may be seen in some mudfishes (*Protopterus annectens*), now in the Zoological Gardens of London. Eight rather young ones, of from six to eight inches long, were brought to England in the summer of 1889, and have ever since occupied one capacious tank. It was soon seen that they viciously snapped at each other, maiming and nipping off each other's filamentary fins, then about two inches long, but which, however, soon grew again. By degrees, and particularly within the last six months, I observed that, in consequence of frequent mutilation, the fins did not attain their normal length, but were stouter and flatter, less and less filiform, and with a more distinct fringe, as if nature were compensating in breadth what was lacking in length. The fish, being now much grown, snap at each other with greater force. The biggest is nearly two feet long.

During our unusually severe winter my observations were suspended, and I was therefore greatly surprised in February to find that one of

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[1] *Zool. Anz.*, XIV., 70, 1891.

the mudfishes had meanwhile developed a trifid member (the left pectoral fin) like the accompanying sketch (Fig. *a*). The keeper informed me that some weeks previously that fin had been bitten, but not quite severed, about midway, leaving a jagged wound with terminal portion pendant. It had now not only healed, leaving no trace of the wound, but the nearly severed portion had become firm and solid, forming one direct, tapering line from the body. The two lateral segments were, when quiescent, at right angles with the middle fin (or branch?); but

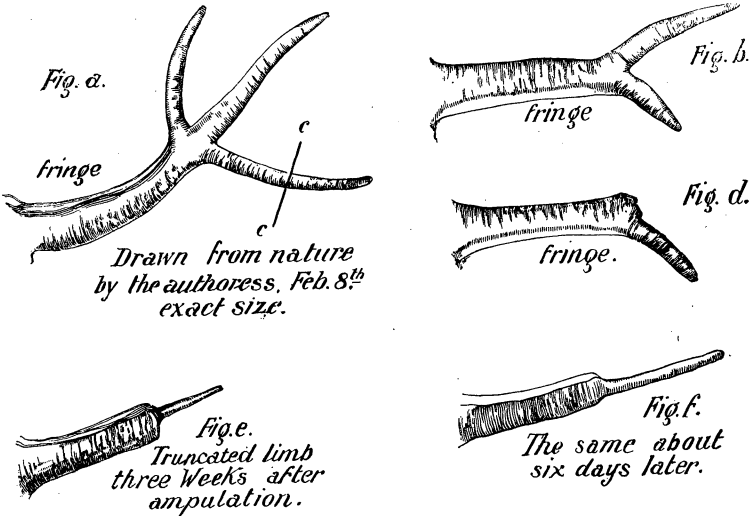
Fig. a.
fringe
c
c
Fig. b.
fringe
Fig. d.
fringe.
Fig. e.
Fig. f.

Drawn from nature by the authoress, Feb. 8th exact size.

Truncated limb three Weeks after amputation.

The same about six days later.

Abnormal developments in fins of the Mud-Fish drawn from life, by the Authoress Feb. & March 1891.

with the movements of the fish they collapsed or expanded freely as might be, and as far as I could decide each one appeared to possess independent action. They were flat, thin, exceedingly pliant and membranous, especially towards the edges; and when the fish was detained in a net out of the water, and I attempted to examine the limb more closely, it was flapped about vigorously, or it clung to the net, and to handle it would have invited a vicious and forcible bite. The segments somewhat resembled the tail of a tadpole.

Another of the mudfishes had grown a bifid fin (Fig. *b*), though one cannot affirm positively that a portion had not been nipped off before it was observed, for three days afterwards it was already partially gone (Fig. *d*), and the trifid fin had also been bitten, as at the lines *c c*. Concluding that these singular developments were worthy the attention of our scientific authorities, I lost no time in sending a description of them to Dr. Günther and Mr. Boulenger, even venturing to suggest that before they were eaten off by degrees a snip of the professional scissors might preserve the specimen for the museum. Mr. Boulenger, in consequence, secured the trifid limb, and in due time the result of his investigations will appear in the Zoological Society's "Proceedings." I observe, too, that the long, vertical fin and also the tail, when bitten, now no longer regain their normal form as they did at first, but remain indented with broad, rounded lobes, and with an indurated edge, like a cord. The whole development strikes one as an example of rapid evolution; as if Protopterus, after many fruitless attempts to restore its slender limbs, had "improved" upon them, growing them stouter and stronger to assist it in swimming, compensating in bulk what it could not acquire in length. But this is mere imagination on my part. I must leave to science to account for the anomaly.

The amputated limb healed entirely, with the angles rounded off, in in three days. Within three weeks a point (Fig. *e*) grew out from the truncated limb, but not in the center. In a few days more the point was nearly three-fourths of an inch long and more in the center (Fig. *f*). It will be closely watched.—CATHERINE C. HOPLEY.

The Lower Jaw of Sphenodon.—It seems to me that there has never been given a correct description of the lower jaw of Sphenodon. Günther[2] writes in 1867, in his "Anatomy of Hatteria": "A part of the sutures between the bones of which the lower jaw of lizards is generally composed have entirely disappeared (if they ever existed), so that the following bones only can be distinguished. The dentary (*u*) forms nearly entirely the outer surface of the mandible, a comparatively small articular portion, and the top of the coronoid process excepted. There is a very distinct foramen between the dentary and articular, penetrating to the inner surface of the mandible. The splenial (*v*) is narrow elongate, behind twisted downwards to the lower side of the mandible and terminating about three millims. from its extremity. The coronoid (*x*) is triangular, covering with one angle the cartilage of Meckel, and forming with another the coronoid process. The articular bone (*w*) is very peculiar; if an angular bone was present at an early age it has now entirely coalesced with the splenial, there being scarcely any osseous projection behind the articulary surface. The articular surface itself does not correspond in form with the condyle of the quadrate bone, being much elongate in the direction of the longitudinal axis of the body, and, in fact, nearly four times as long as the opposite articular surface."

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[2] Philos. Trans., 1867, pp. 600, 601, Pl. XXVI., Figs. 6, 7.

Exactly the same description is given by Brühl:[3] "Der Hatteria Unterkiefer setzen wirklich in jeder Hälfte nur vier elemente züsammen: 1. dentale, d.; 2. articulare, ar.; 3. coronoideum, cor.; mit einen mässigen processus coron.; und 4. marginale, marg. (mihi = angulare autor. = spleniale Owen, Günther); die sonst bei Echsen meist vorkommenden Mehrstücke; 5. ecto-complementare, ec. cp. (mihi = supra angulare autor.) und 6. endocomplementare, en. cp., auch operculare, op., *fehlen* bei Hatteria *spurlos*."

In a lower jaw of Sphenodon (length of each ramus 56 mm.) I find all the six elements of the Reptilian lower jaw represented. The whole arrangement, however, is only comparable with that seen in the Testudinata and not with that of the Squamata.

The dentary, coronoid, and angular (splenial Günther, marginal Brühl) are described correctly by both Günther and Brühl. The remaining portion of each ramus is considered as articular. In the specimen before me this portion plainly consists of three elements,—an articular, splenial, and supraangular.

The articular is a small element, only visible from above and very little from behind. It is surrounded by the splenial on the inner and the supraangular on the outer side; it is very much like the corresponding element in the Testudinata. The supraangular is that portion of Günther's and Brühl's articular which is seen on the outside and inside. It is connected with the articular, the splenial, the angular, the dentary, and the coronoid. Between this element and the coronoid the foramen is placed. The splenial is the inner portion of Günther's and Brühl's articular. It is connected with the articular, supraangular, angular, and coronoid. We have therefore a condition which is typically that of the Testudinata. In all the Testudinata, however, the angular separates the splenial and supraangular behind; in Sphenodon the splenial and supraangular meet at the posterior lower end of the jaw.

The structure of the lower jaw in Sphenodon gives another support to the opinion of the affinity between Rhynchocephalia and Testudinata.—G. BAUR, *Clark University, Worcester, Mass., April 8th, 1891.*

On the Development of the Male Copulatory Organs in Snakes.—Although the adult anatomy of the male copulatory organs in snakes has been carefully worked out by Neumann[4] and others, very little seems to be known of their development. Rathke[5] is, so far as I know, the only one who has studied it; his account deals merely with superficial appearances, and is therefore very incomplete.

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[3] Brühl. Reptilienkopf. Wien, 1886, Tafel p. CXLVIII., Figs. 12, 13, 17, 18, 19, 20.

[4] Begattungsapparat der Schlangen. Leipzig, 1884.

I have been able to make out a few points in the early history of these organs from specimens collected in July, 1890, at the Marine Biological Laboratory, at Cold Spring Harbor, Long Island. My specimens were mostly embryos of the black snake (*Bascanium constrictor*), of from the second to the ninth week of embryonic life, together with a few garter snake (*Eutænia sirtalis*) embryos, taken at a considerably later stage in their development.

First, a word on the general anatomy of these organs. The male copulatory organ in snakes, as in lizards, is made up of two distinct parts. Each part is in the form of a long, hollow sack, more or less irregular in outline, and in some species bifurcated at the end. A thick layer of connective tissue, containing numerous cavities in its outer portion, forms the greater part of the walls of this sack. These cavities are connected by a branch with the dorsal artery, and it is by a flow of blood into them that erection of the penis is accomplished.

Outside of this connective tissue is the epithelium, a continuation of that covering the rest of the body. This epithelium consists of two layers. The inner, called by Neumann the "stratum mucosum," is made up of large, columnar cells arranged side by side, and containing prominent nuclei; the outer is a layer of very much flattened cells with deeply staining nuclei, joined by their edges to form a thin covering to the whole.

On the inner side of each penis, running obliquely from base to tip, is the *semen canal.* This is a deep depression, approximately anchor-shaped in cross section. During copulation the two parts of the penis are brought together in such a way as to make of these two canals one long tube, which then serves to conduct the semen into the oviduct of the female.

Closely set all over the surface of the penis are numerous cartilaginous teeth-like bodies, which arise in the connective tissue, and project out through the epithelium. Their exact function is not known, though they have been regarded as "wollustorgane," or contrivances for stimulating the sexual organs. It is possible that they may serve to hold the sexes more firmly together during the act of copulation.

These penes arise as external appendages. At the close of embryonic life, however, they are drawn back into two pouches, one on either side of the body just behind the cloaca. This action is effected by a long muscle, the *retractor penis*, which runs from the point of the penis through its interior back for a considerable distance in the tail; there it is attached to one of the caudal vertebræ. The action of this muscle is such as to turn the penis inside out,—as the finger of a glove could be turned,—back into its place under the skin. At times of copulation the organs are everted, chiefly by an influx of blood into their erectile tissue.

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[5] Entwicklung. der Natter. Königsberg, 1839.

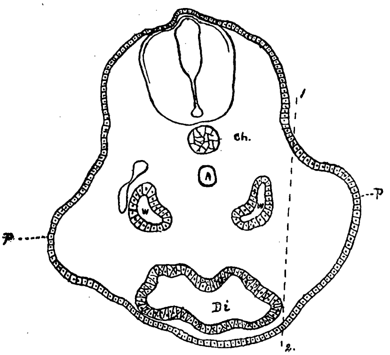

Fig. I.

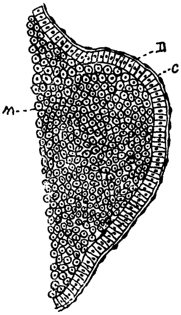

Fig. II

The copulatory organs first appear in embryos of about the sixth week. At this stage most of the important organs of the body are formed; the body has completely closed in, except at the umbilicus, the food-yolk not being entirely consumed until a much later period. The wolffian ducts open into the cloaca, but the ureters have not yet grown so far back.

The first appearance of the penes takes the form of two ridges, one on either side of the body, and extending from a point a little ahead of the cloaca to about opposite its posterior end. In sections across the body at this stage (Fig. 1, *p*) these ridges can be seen as bulgings of the body-wall. These bulgings are filled (Fig. 2) with an undifferentiated mass of mesoderm cells, similar to and continuous with those composing the body proper. The whole is covered with the characteristic double-layered epithelium.

The further growth of the penes from these ridges reminds one strongly of the manner of formation of the posterior appendages in the chick, from the end of the wolffian ridge. The extreme posterior end of each ridge swells out, forming a rounded prominence, the "nipple-shaped swellings" of Rathke. The remaining portions of each ridge grow no further, and finally disappear. In embryos of a week later no trace of them is to be found.

These swellings, however, continue to enlarge, and form the penis proper. They grow very rapidly in length, and attain their full size in about three weeks. They are then equal in length to three-quarters the vertical diameter of the body.

Simultaneously with the growth of these swellings a differentiation of the mesoderm cells in their interior begins. The cells near the exterior gradually lose their round form, become more and more angular, their ends prolonged more and more into slender processes, until, in my latest sections of the black snake, they can be seen to be well on their way toward the formation of connective tissue. Among these cells clear spaces with a regular outline appear (Fig. 4, *n*). These are lined with a layer of flat cells, similar to those Neumann describes as lining the blood cavities in the adult penis. They are the beginnings of the blood spaces, which, with their connective tissue walls, compose the erectile tissue in the adult.

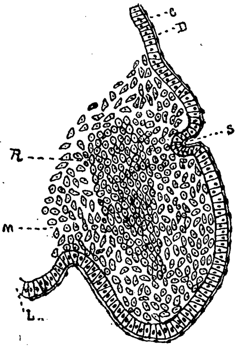

Fig. III.

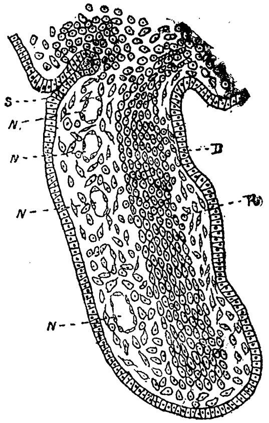

Fig. IV

While this change into connective and erectile tissue is going on among the outer mesoderm cells, those on the interior undergo a differentation which leads to the formation of the *retractor penis*. In embryos of about the seventh week the first rudiments of this muscle may be seen as a thickening or crowding together of the mesoderm cells in the middle of each organ (Fig. 3, *r*). These cells elongate, become nearly elliptical in form, and arrange themselves in rows, thus giving rise to the muscle fibres.

In the adult penis there are two sets of these fibres, a large, inner, longitudinal band, with an incomplete circular band surrounding it.

The separation into two sets of fibres can be readily seen in the manner of grouping of the mesoderm cells. The exact manner in which muscle fibres arose from mesoderm cells, I was, however, unable to determine from my specimens.

Neither semen canal nor cartilaginous "teeth" had been found in the latest of my black-snake embryos, but both were present in the garter snakes. From this I infer that they arise at about the same time, and at about the same stage in the development of the organs. The semen canal is lined with large cells, continuous with those of the stratum mucosum, and is undoubtedly formed by an invagination of the epidermis. The "teeth" are modifications of the connective tissue walls, as Neumann has shown, but the exact manner of this change I could not determine.

Lying behind the cloaca in the adult snake are two cone-shaped glands, with ducts opening to the exterior just behind the cloacal opening. These are the "*anal sacs*," and secrete a stickly fluid, with a highly unpleasant odor. Rathke thinks this odorous fluid enables the sexes to find one another during the breeding season.

These glands occupy, in the female, a corresponding position to that of the drawn-in penis in the male. Hoffmann[6] quotes Retzius to the effect that they occur only in the female, and are homologous with the male penis. Neumann finds them, though much aborted, in the adult male. In embryos I find them present, and of equal size in both sexes. They cannot, therefore, be considered homologues of the penis. Their ducts open to the exterior in the male,—not, as Rathke states, on the *inner* side of each penis, but on the *outer* side. In the female they open in corresponding positions.

These glands first appear in the embryos of the seventh week. Rathke's statement that they arise as invaginations of the posterior wall of the cloaca does not agree with my observations. In my specimens they were formed by an invagination of the *outer* wall of the body just above the penis (Figs. 3, 4, *s*). The gland is formed, as Rathke states, by a continued growth inward of this invagination. Both layers of the epidermis are carried in with it, and enter into the composition of the sac. In the "grosszelligen Plattenepithel," which forms its outer coating, Neumann recognizes a transformed stratum mucosum, now exercising a glandular function; in a thin layer covering its inner surface he finds the remnants of the original stratum corneum.—AARON L. TREADWELL, *Biological Laboratory of Wesleyan University, Feb. 6th, 1891.*

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[6] Bronn's Thier Reichs, p. 1557.

EXPLANATION OF FIGURES.

FIGS. 1 and 2 are drawn to the same scale. Figs. 2 and 3 are drawn to a scale a little larger than 1 and 4.

FIG. 1.—Section through body of embryo of black snake, in front of the cloaca.

FIG. 2.—Portion of Fig. 1, to right of line 1–2, drawn to larger scale.

FIG. 3.—Right penis of black-snake embryo, two weeks older than Fig. 1. Section passes through body just behind the cloaca.

FIG. 4.—Section of left penis of black-snake embryo, one week older than Fig. 3. Section taken just behind cloaca,

P, ridge which marks first appearance of penis; *ch*, notochord; *a*, dorsal artery; *w*, wolffian duct; *d*, alimentary canal; *m*, mesoderm; *d*, stratum mucosum; *c*, stratum corneum (not figured in 1 and 2); *r*, retractor muscle; *s*, beginning of anal sac; *n*, blood spaces forming in the mesoderm; *l*, edge of posterior wall of cloaca.

The Quadrate Bone.—R. Broom thinks[7] that all previous morphologists have been in error in trying to recognize the quadrate among the bones of the middle ear of mammals. He thinks it forms the articular cartilage.

"Some of the Causes and Results of Polygamy Among the Pinnipedia."—In the February number of the AMERICAN NATURALIST (Vol. XXV., pp. 103–112), Mr. C. C. Nutting has published some interesting notes on sexual disparity among polygamous seals, and deductions from the observations recorded. Mr. Nutting, however, was not the first to draw attention to such facts and the principles involved. Over twenty years ago (January, 1871) the subject was noticed, and the resulting conditions tersely formulated in the AMERICAN NATURALIST (Vol. IV.). In a review of Mr. Allen's then recent memoir on the eared seals I published the following paragraph immediately after one on the genetic relationships of the families of Pinnipeds:

"In this connection it may be recalled that while in the monogamous Pinnipeds, or those living in small communities, there is little difference in size between the males, in the social species, or rather those of which the males have harems, the males are vastly larger than the females. Macrorhinus, of the Phocids, and all the Otariids belong to the latter category. The difference between the sexes would be readily explained by Mr. Darwin on the principle of natural selection. It is evident that the larger and more vigorous males would be the eventual possessors of the females, and the disproportion of the sexes would in lapse of time culminate, till it had reached a proportion when obvious mechanical difficulties would more than balance the advantages resulting from superior size and vigor, and when, therefore, farther disproportion would be arrested. It may be added that the like disproportion of the sexes in the forms above enumerated furnishes not the slightest evidence of more intimate primordial affinity, for like causes would in each special case, such as this, produce like effects."—THEODORE GILL.

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[7] *Ann. and Mag. Nat. Hist.*, VI., 409, 1890.

Errata of article on Chromatophores in fish embryos in February NATURALIST: Page 113, 9 lines from bottom, read oviparous for viviparous; page 114, 15 lines from top, read periblast for epiblast; page 116, 16 and 29 lines from top, read periblast for epiblast; page 117, 25 lines from top, read periblast for parablast; page 118, 2 lines from bottom, read *Hemirhamphus* for *Hemisbamphus*.—C. H. EIGENMANN.

EMBRYOLOGY.[1]

The Later Larval Development of Amphioxus.[2]—Mr. Arthur Willey has published a most interesting account of the later stages of the larval Amphioxus. It is a continuation of a preceding paper by Professor Lankester and himself on the younger larva. In the first paper the larva, with its large mouth on the left side and the single row of gill-slits on the right, was described; also the structure and position of the club-shaped gland and the endostyle were given, and the origin of the atrial folds. In the present account the author begins with a larva having fourteen primary gill-slits arrayed in a single row, and all on the right wall of the pharynx. Above these and on the same side is to be seen a thickened rod of endodermal tissue with six swellings. These later break through to form six secondary gill-slits, second to seventh inclusive. The atrium is still open in front. The posterior primary gill-slits now begin seriatim to close and atrophy, beginning with the fourteenth and continuing until but eight remain. At the same time this primary row of gill-slits begins to move around the ventral surface to the opposite side of the larva (the left), where they assume their adult position. Meanwhile the secondary gill-slits increase in number and size, and occupy the right side of the

[1] Edited by Dr. T. H. Morgan, Johns Hopkins University, Baltimore, Md.

[2] *Quart. Jour. Micro. Sci.*, March, 1891.